

NASA Air Quality Capacity Building Activities: Bridging the gap between science and policy

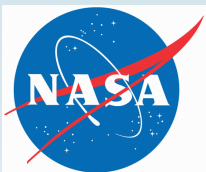
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University of Maryland Baltimore County**

**AEROCENTER Seminar
February 15th, 2011**

Acknowledgements

- **Lawrence Friedl, NASA Applied Sciences Program**



Presentation Overview

- **Motivation: NASA Satellite imagery for decision-support**
- Overview of NASA Air Quality Training activities
- Air Quality Application Areas
- Future training activities

Program Motivation

NASA data are underutilized

Train end-users on how to access, visualize, interpret, and ***apply*** NASA Earth Science Data in their professional area

Barriers to NASA Data Utilization

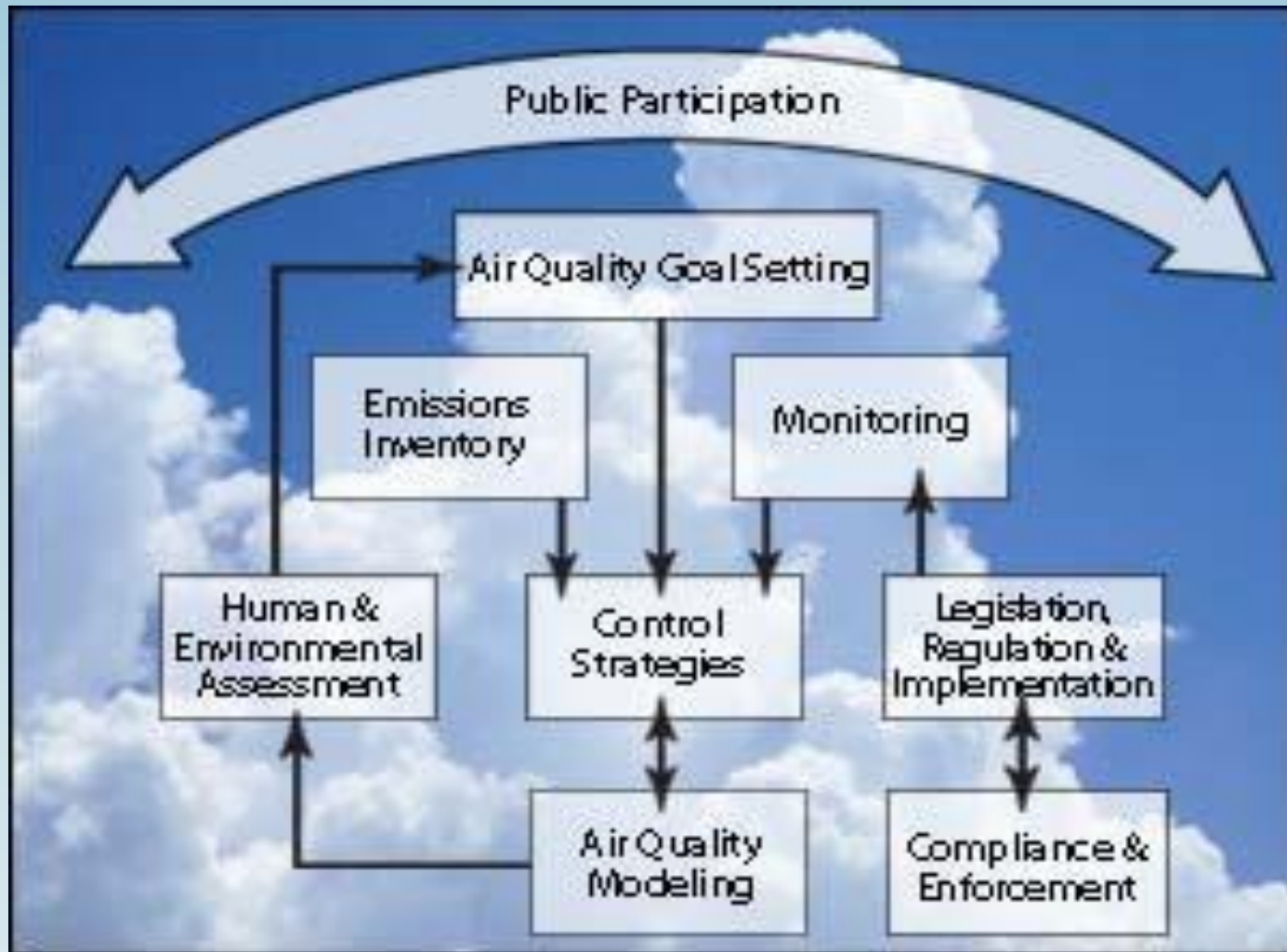
➤ Knowledge gaps

- *Cost*: NASA data are free, really !! but many don't know it
- *Data Access*: Not aware of resources available (e.g. web tools, or how to order data)
- *Applications: what are they and which data sets ?*
Data are appropriate for certain environmental monitoring and management activities, IF used appropriately.

Barriers to NASA Data Utilization

- **Institutional:** prioritization, lack of man-power and needed technical expertise.
- **Access to research results:**
Policy-relevant research remains largely inaccessible beyond the relatively small research community
 - *cost of journals*
 - *knowledge gaps about data sets and their application to air quality management activities*

Air Quality management activities in the U.S



Source: U.S EPA

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Air Quality Workshop Goals

- Teach appropriate use of remote sensing data
- Navigate the imagery/analysis web-tool maze
- Make NASA applications-research more accessible.
- Collaborate with applied end-users to:
 - Identify air application areas of remote sensing data
 - Plan future training activities

Project Members

- Ana Prados (UMBC/JCET) – project lead and training
- Richard Kleidman (SSAI) - training
- Maria Stenborg (student) - Spanish translations

New Members for 2011

- Pawan Gupta (UMBC) - training
- Marines Martins (SSAI) - admin and logistical support
- Yang Liu (Emory University) – health applications

Accomplishments

- Developed a set of re-usable *instructional modules*
- ***Conducted 16 national and international training activities*** (10-45 students each) reaching +380 users since January 2009.
- Developed a ***Case Study Inventory***
- ***Students becoming Teachers:***
 - *San Francisco Bay Area Air Quality District using OMI NO₂ – presented at UC Davis workshop Dec. 2010*



7 SEAS
Workshop,
Singapore 2009

Accomplishments

- **Developed trainings at State Regulatory Agencies:**
California Air Resources Board -
2-day training preceded by talk
for managers, very successful
- **Reached applied end-users in
Region 3 and 4 state regulatory
agencies: MD, VA, DC, DE, NC**

*Typical Workshop Attendees Include:
Local, Regional Federal Policy-makers
Air Quality Professionals and Managers
Students and Researchers*



NASA Training at California Air
Resources Board, December 2010

Who are we training ?

- **Air Quality Managers and Regulators**
EPA, state and local regulatory agencies, US Forest Service
- **Scientists/Technical:**
Meteorologists, air quality forecasters and modelers, health scientists, AQ researchers
- **Other/public:** project managers, reps. from health agencies, World Bank

Expertise

ANY Audience can span a large range in expertise:

- **No background in remote sensing** and little science background
- **No background in remote sensing and some science background**
- **Introductory expertise** with satellite data
- **Moderate expertise** with satellite data

Developing a Training Workshop

- **Get to know the audience:** area of application or interest and level of scientific understanding
- **Work closely with host institution !**
- **Adapt or develop training modules and Case Studies** to suit participants
- **Conduct 1-3 Day trainings (or 5 days !)** presentations and Case Studies

Feedback and Surveys are utilized to evaluate the value of the workshops to decision making activities and guide future workshops

Structure of Remote Sensing Workshops

- **Basics of remote sensing:** instruments, orbits, product overview, data formats
- **Critical Thinking of Remote Sensing:** Strengths and caveats in the data products, retrieval characteristics
- **Case Studies and Hands-on Activities (via visualization Tools and Google Earth)**

The Challenge: Balancing too much versus too little information

- Avoiding misuse of NASA Data: convey the needed scientific information to ensure appropriate use of the data
- Can't overwhelm users with too much high level scientific background/algorithm details
- ***Most training activities have a RANGE in levels of expertise and application areas.***



NASA Satellite Instructional Modules

| End User Question | Scientist/Module Answer |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| How reliable is this data ? | Noise and systematic errors |
| Can I use this satellite data to make GROUND level air quality/health assessments ? | PBL Sensitivity; vertical distribution of aerosols and trace gases; challenges of working with column data |
| Is this data valid everywhere in the world ? | Land surface issues, biases due to cloud contamination, etc. |
| Are all Aerosol products the same ? | Instrument – to instrument differences (calibration, footprint, and many others) |
| Can I use this product to analyze urban scale pollution ? | Satellite resolution (Level 3, Level 2), etc. |
| Why is there only one image per day and temporal resolution issues ? | Polar orbiting satellites, local overpass time |

Data Products

- Aerosols: MODIS, OMI, Calipso, AERONET, GOES
- Trace Gases: OMI NO₂, SO₂, Formaldehyde
- Fire Products: Rapidfire, NOAA Hazard Mapping System
- New data products in 2011

Main Web-tools for NASA Air Quality Trainings

- ✓ RapidFire
- ✓ LAADSWeb Browser: image access (L1 and L2)
- ✓ MODIS-Atmos Site: image access
- ✓ Giovanni – visualization and analysis; data intercomparisons
- ✓ AERONET Synergy Tool: Data intercomparisons
- ✓ RSIG (EPA): Satellite/Monitor/Model Comparisons
- ✓ IDEA (NOAA): Satellite/Monitor comparisons
- ✓ Google Earth: used with most of the above

Case Studies and Hands-On Activities

Decision-Support Template with step-by-step instructions:

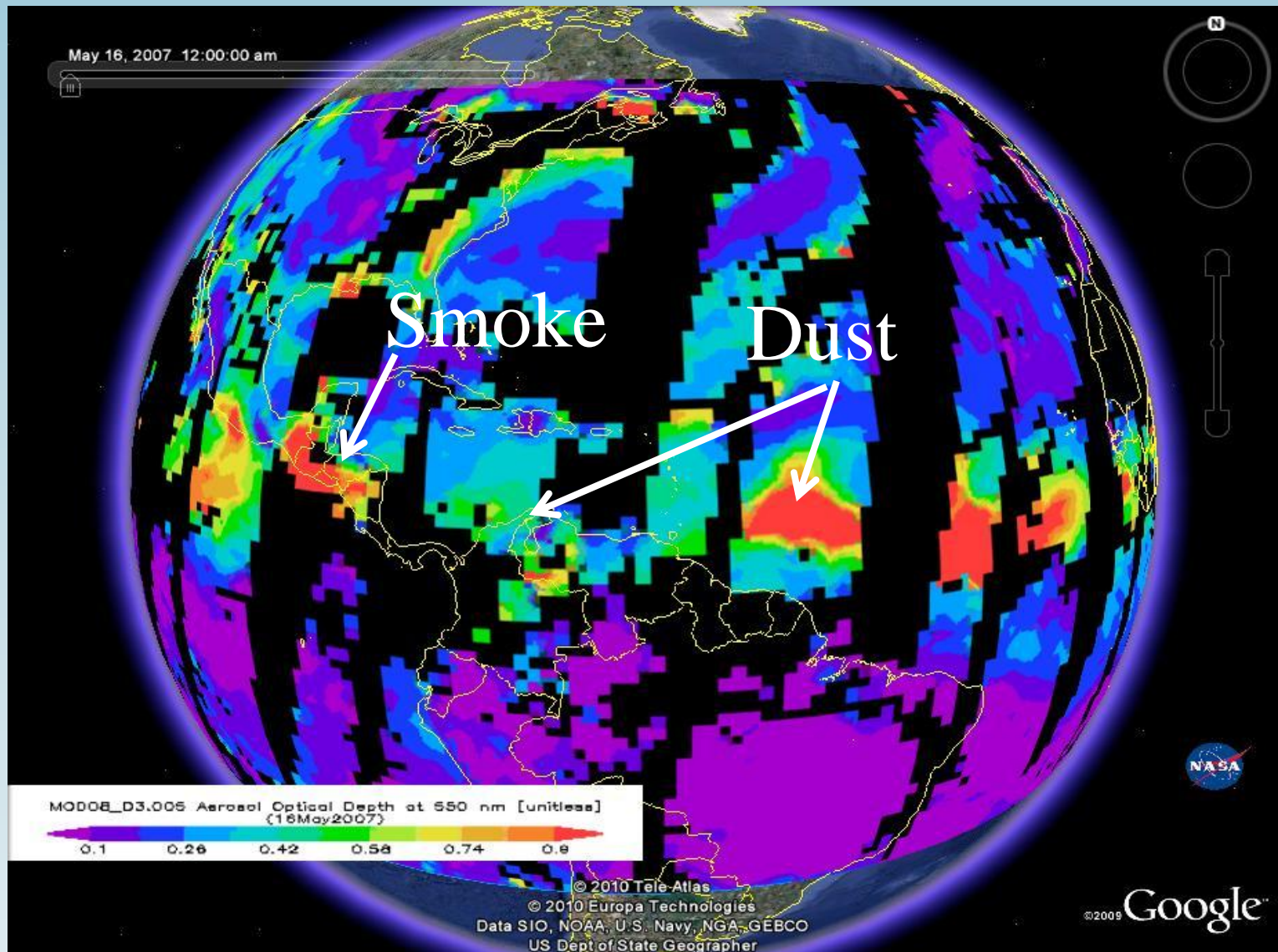
- 1) Access to imagery
- 2) Access to meteorological, model or other information
- 3) Utilization of image analysis tools
- 4) ***Air Quality Assessment:***
 - Type of event: smoke, dust ?
 - Where is the pollution coming from?
 - Potential health impacts



University of North Carolina, October 2009

Visualization Tools:

May 16th, 2007: Global View of Transported Dust and Regional Smoke



Source: NASA MODIS Giovanni Image on Google Earth

Case Study Analysis

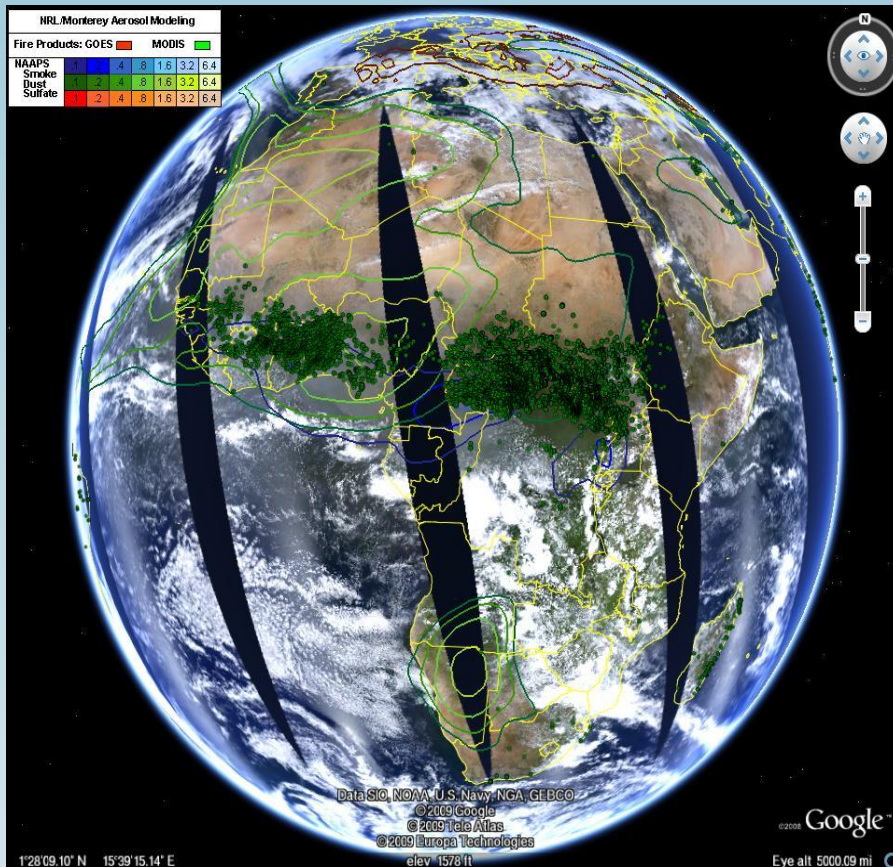


Image from one of the training Case Studies showing MODIS fire locations and True Color Imagery – dust and smoke. Google imagery provided by the NRL Fire Locating and Modeling of Burning Emissions (Flambé) Program.

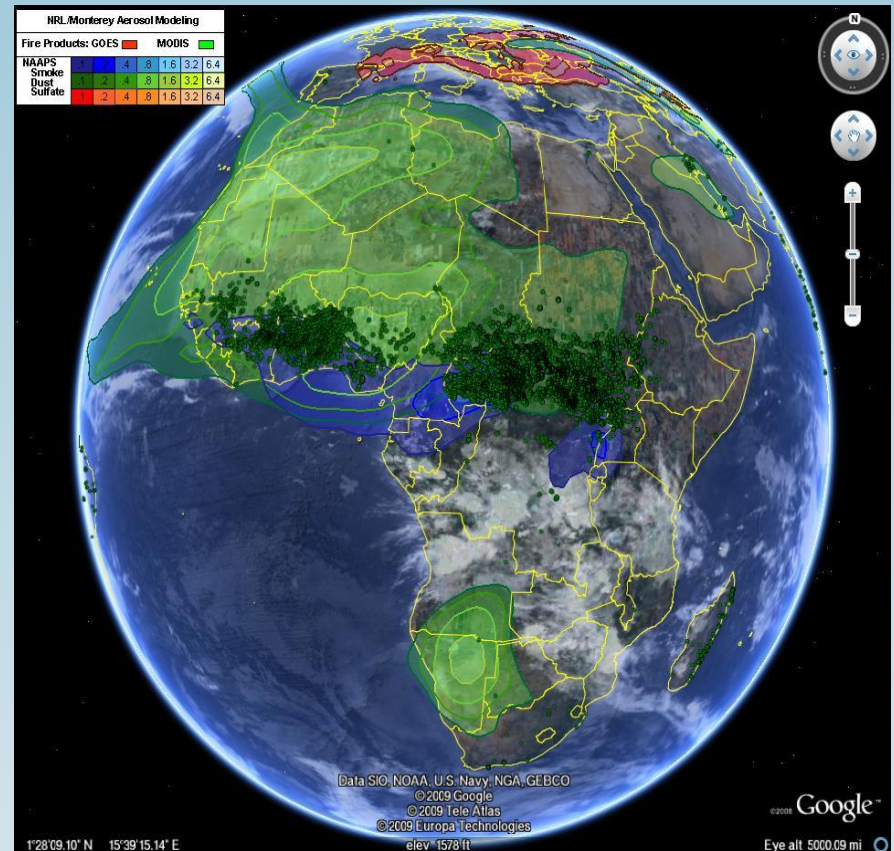


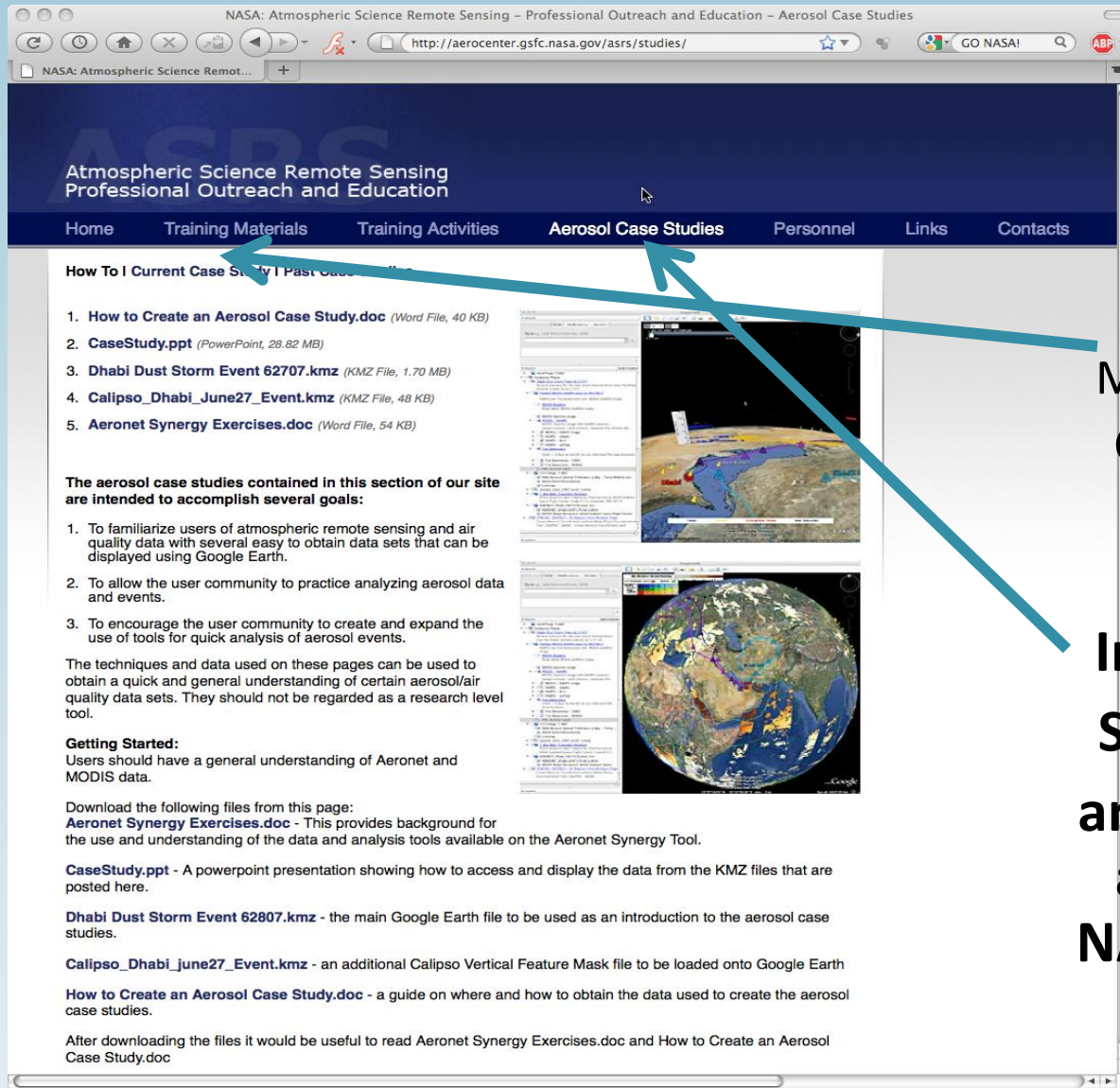
Image from one of the training Case Studies, showing MODIS fire locations and modeled pollution – dust and smoke - from the NRL Fire Locating and Modeling of Burning Emissions (Flambe) Program, which incorporates NASA Satellite real-time observations in its model predictions.

Tools and Case Studies

- A vehicle for teaching data characteristics
 - cloud cover and other data gaps
 - temporal and spatial variability in instrument sensitivity, and data biases
 - strengths and weakness of various data sets
- Applicability of data tools: suitability varies with application area

Project Website

<http://arset.gsfc.nasa.gov>



Publicly available
Educational
Modules in English,
Chinese and soon
also in Spanish

**Interactive Case
Studies. Submit
an entry/analysis
and win a free
NASA workshop !**

Quarterly Air Quality Contest

Submit your analysis....

**Win a copy of NASA's Our
Changing Planet or a free
training and....**

become a star

**We will post the name of the
winner on our website**

Presentation Overview

- Motivation: NASA Satellite imagery for decision-support
- Overview of NASA Air Quality Training activities
- **Air Quality Application Areas**
- Future training activities

Many areas in the U.S Don't meet National Ambient Air Quality Standards (NAAQS)

- Air Quality has improved considerably in the U.S since enactment of the 1970 Clean Air Act Amendments. Yet many areas do not meet Ozone and/or PM_{2.5} Federal Standards
- The D.C metro area does not meet the current 8-hour ozone standard (in non-attainment), new standard will be even more difficult to meet.

What do applied end-users want ?

Primarily the regulatory community

Not a comprehensive list !

- Data sets to validate air quality forecast models, especially for PM_{2.5}
- Resources to help constrain emissions inventories
- Tools and data to facilitate pollution source apportionment (esp. Mid-Atlantic Region)
- Tools to facilitate CMAQ/Satellite comparisons
preferably utilizing their own model output

Current Application Areas of NASA Remote Sensing Data

Not a comprehensive list

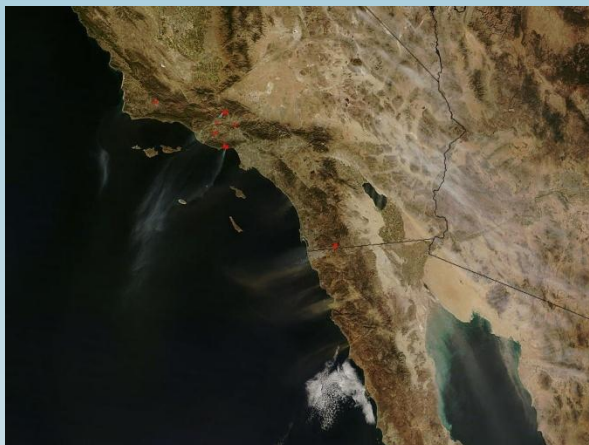
- **Long Range Transport** of air pollution (regional scale). Attainment is a combination of local and upwind sources
- **Improve data coverage and knowledge of air pollution trends** where monitor data are lacking (e.g. forecasting).
- **Exceptional Event analysis:** allows states to obtain an exclusion for a NAAQS exceedance
- **Trace Gas Emissions Inventories and regulatory effectiveness:** (U.S and China Coal Plants)

Long Range Transport of Air Pollution

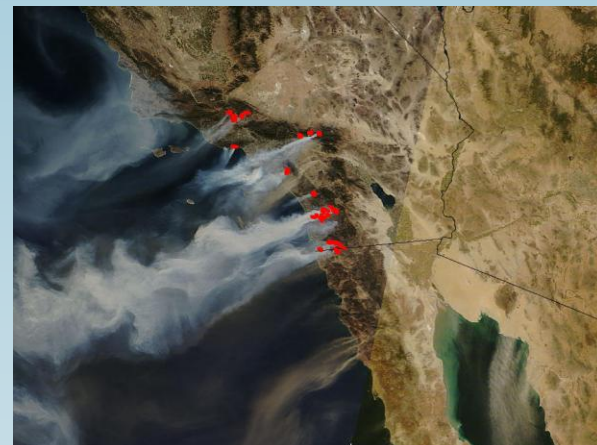
October 20, 2007



October 21, 2007



October 22, 2007



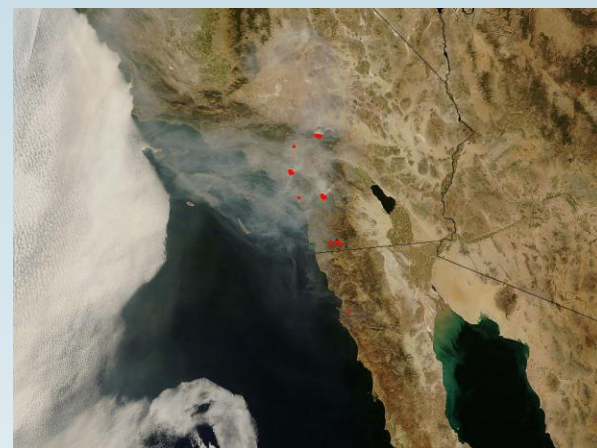
October 23, 2007



October 24, 2007



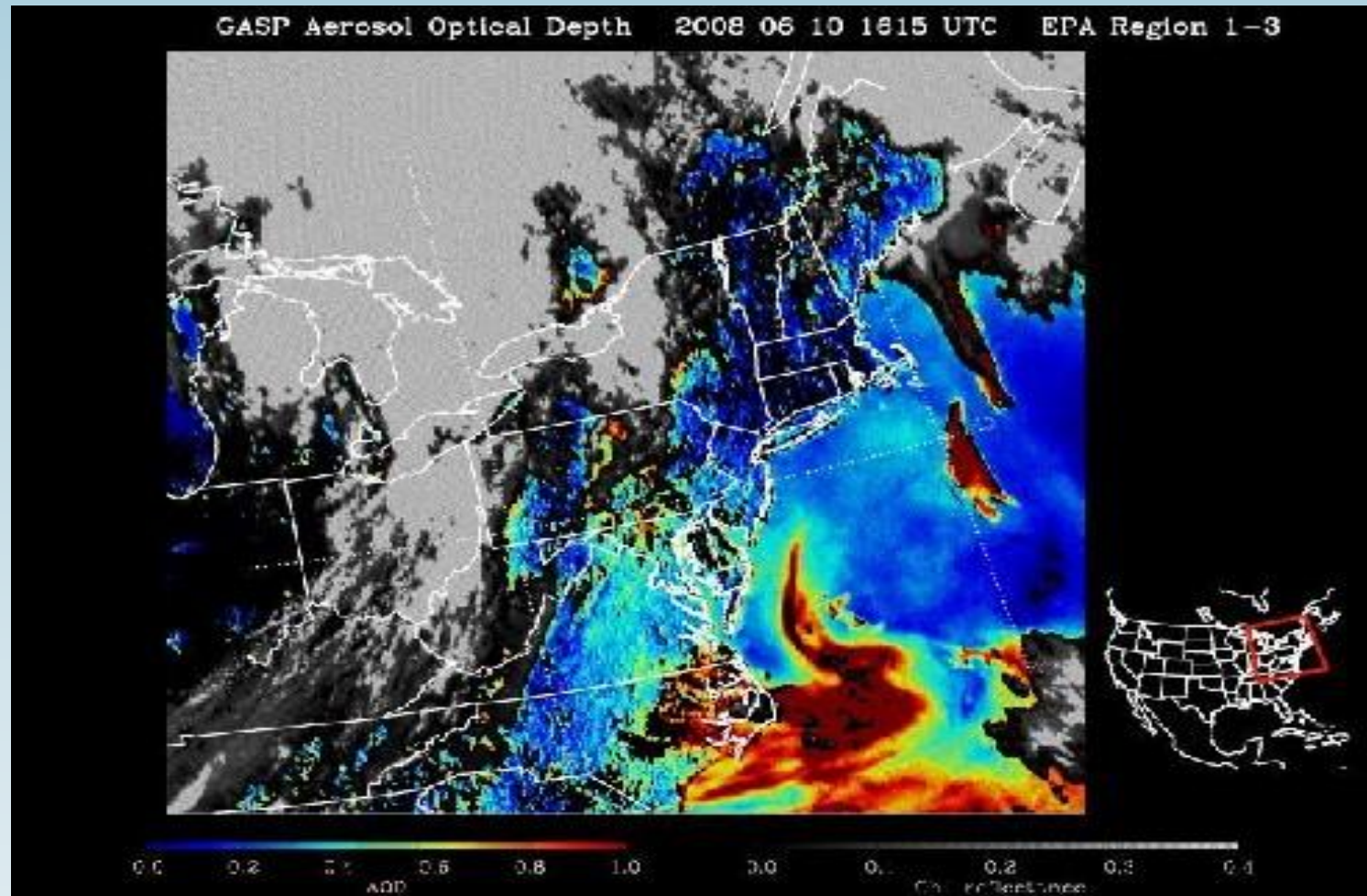
October 25, 2007



Exceptional Event Submittals

Long range transport of air pollution

Virginia, Maryland and North Carolina

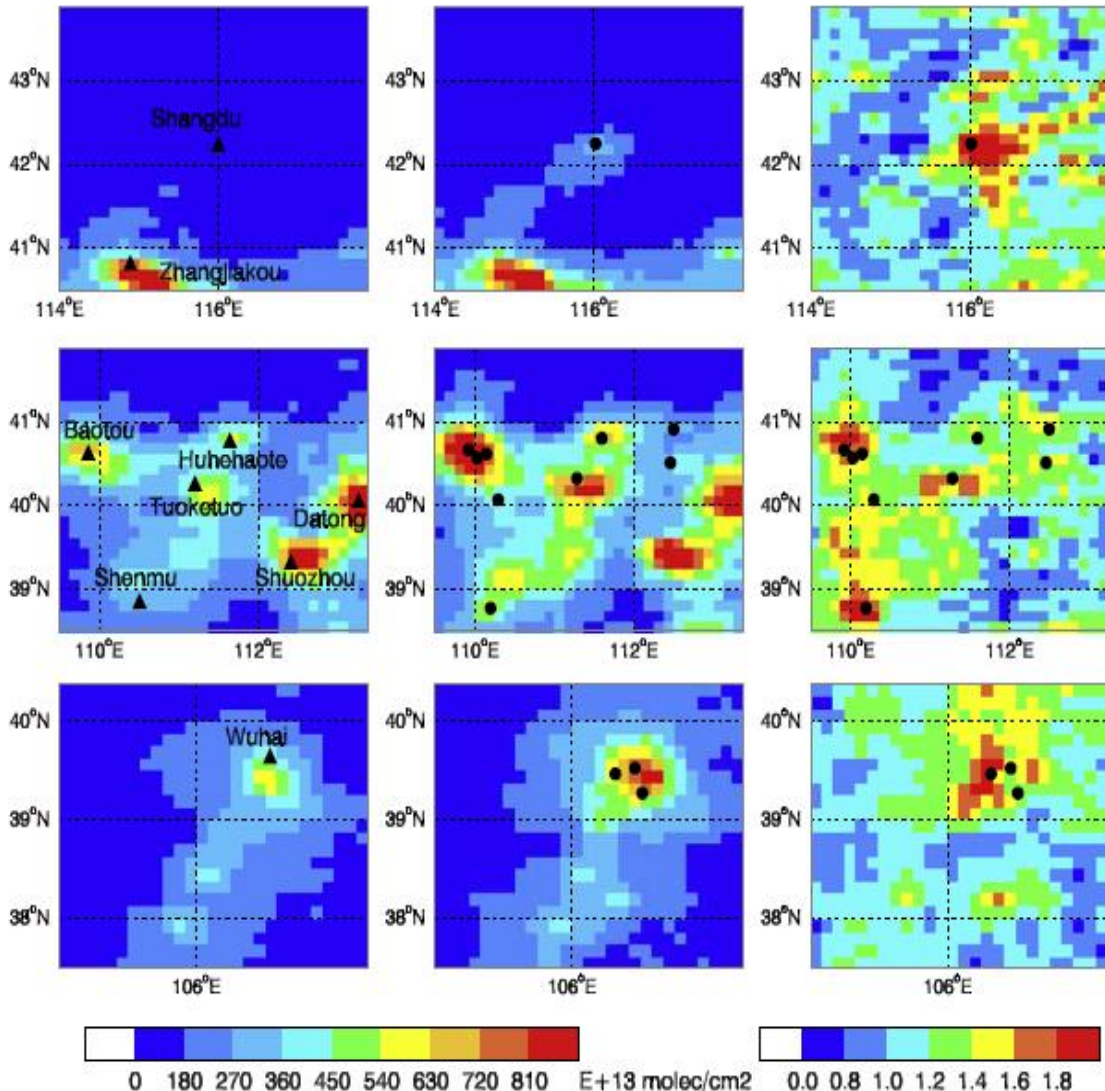


Satellite NO₂ trends over China

2005

2007

Ratio:2007/2005



Zhang et. al., GRL, 2009

- OMI Instrument detects emerging “hot spots” due to new coal plant construction
- Increase in satellite NO₂ in these source regions from 2005 to 2007

Application Areas of NASA Remote Sensing Data

Satellite data **cannot be used quantitatively for enforcement purposes** such as for example to determine whether a region is in attainment or not (Hoff and Christopher 2009).

NASA Remote Sensing Training Program Evaluation

- Surveys are used at the completion of every training to continually improve our workshops
- On-going contact with former trainees has provided some information for program assessment.
- Workshops are very highly rated but we are looking to ways to better quantify the effectiveness of the trainings in improving decision-making activities.

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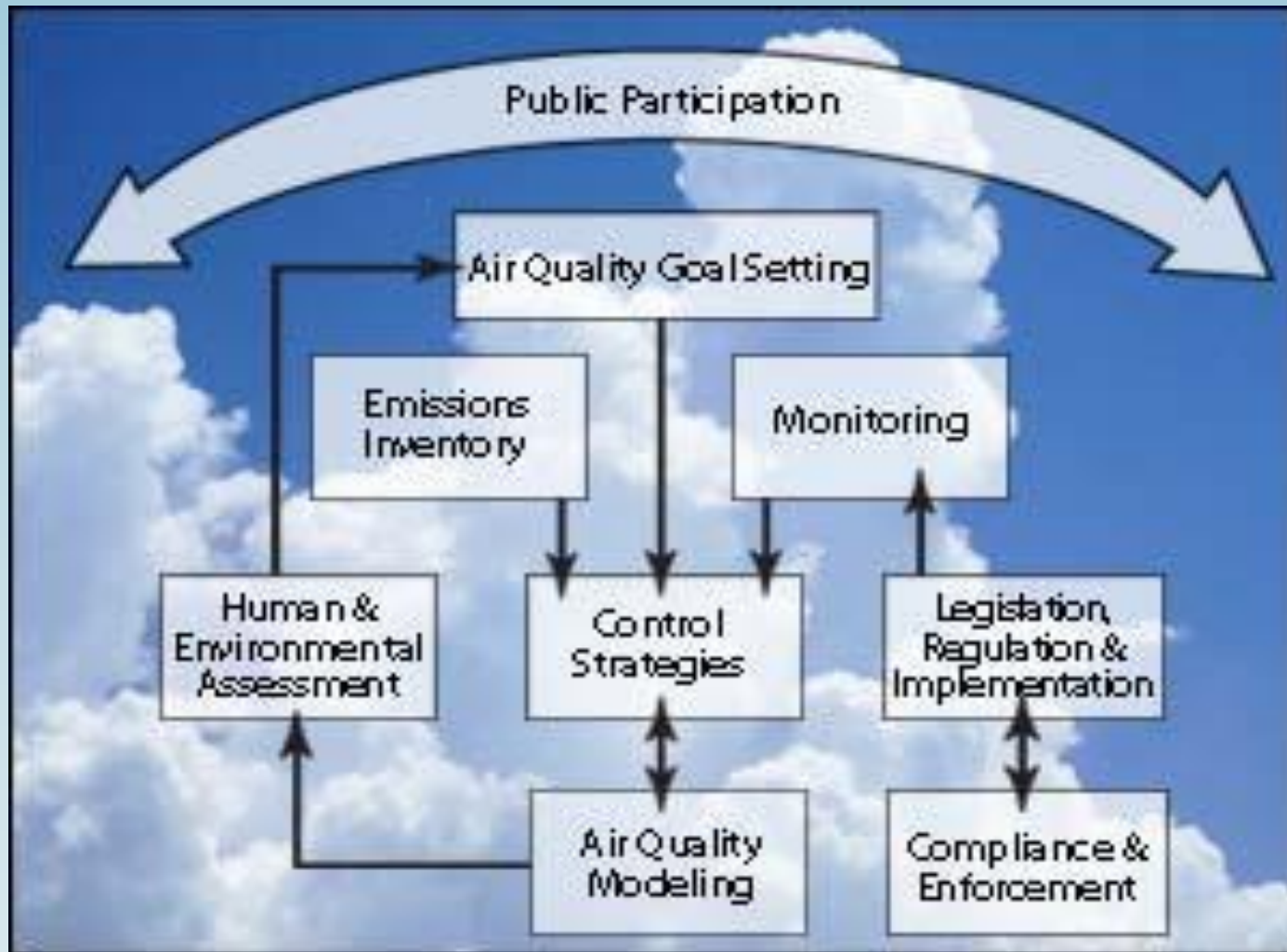
What's new in 2011

- **Application-specific training modules and workshops**
 - Biomass burning and dust events
 - Satellite/model comparisons
 - Health (e.g. PM_{2.5})
- **Additional products and topics (and to support the above):**
 - Aerosols: CALIPSO and MISR
 - Trace Gases: European data sets
 - Future NASA missions

What's new in 2011 (cont.)

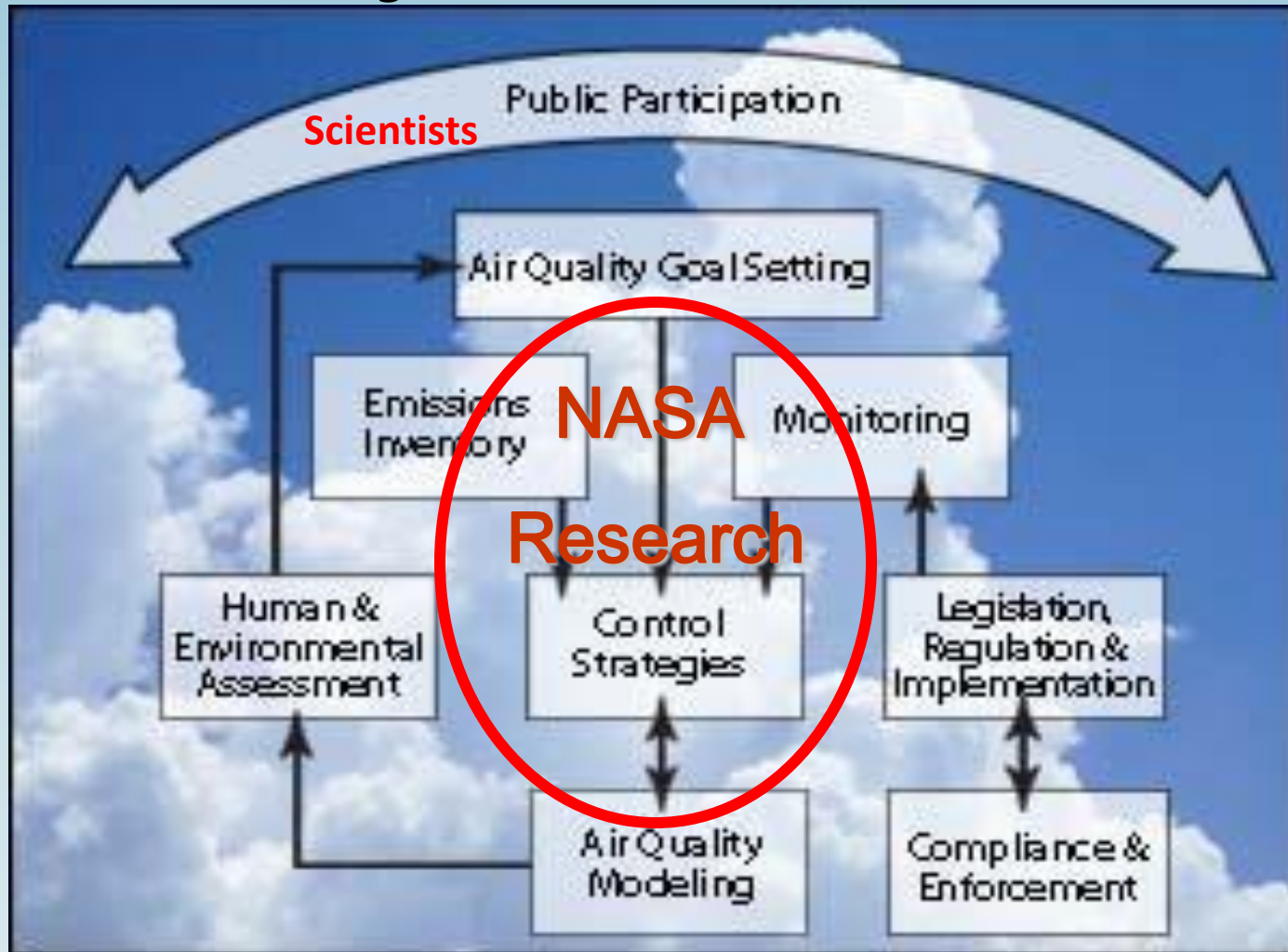
- **Post-survey evaluations**
- **Air Quality Training Advisory Group**
- **Air Quality Management Topics workshop at GSFC**

Air Quality management activities in the U.S



Source: U.S EPA

How does NASA research fit into air quality management activities in the U.S ?



Source: U.S EPA

Proposed Workshop at GSFC on Air Quality Applications topics

*Learn how NASA research fits (or may fit in the future) into
air quality management activities in the U.S*

- Hear from EPA and regional air quality experts
- Learn about current and potential future application areas of NASA data and research
- Helpful for your Applied Sciences proposals
- Make contacts with the end-user community

Future NASA Training Activities: Water Applications

- Apply this training methodology in other application areas :
 - Developed some modules and Case Studies for precipitation, drought and flood monitoring.
 - **Water resources management trainings in 2011**
 - Rainfall amounts and anomalies (current and future)
 - Extreme weather events
 - Temperature trends
 - Land-use products

Future NASA Training Activities: Monitoring Water and land-use

- Heavy rainfall in Guatemala from Tropical Storm Agatha (May 2010)
- Area in and around Guatemala City had some of the highest accumulated rainfall values and rates



<http://www.examiner.com/x-23333-Atlantic-Hurricanes-Examiner~y2010m5d31-Tropical-Storm-Agatha-kills-99-in-Central-America-photos>

heavy precipitation in Guatemala leads to
landslides, and flooding

Other Information

Contact:

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NASA Satellite Training Resources:

<http://arset.gsfc.nasa.gov/>

For updates and notification of upcoming workshops
you can sign up for our list serv:

<https://lists.nasa.gov/mailman/listinfo/arset>